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SOME OBSERVATIONS ON BRAIN ANATOMY AND BRAIN TUMORS.

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SOME OBSERVATIONS ON BRAIN-ANATOMY AND BRAIN-TUMORS.[1]

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In my study of the human brain in the laboratory and at the bedside, two facts, one anatomic, the other clinical, have presented themselves with unusual force; first, the ease and facility with which the knowledge of the anatomy of the brain disappears from memory, and secondly, the almost universal presence of optic neuritis in cases of brain-tumor. The first observation, I dare say, is not an original one—or one connected with the newer researches in neuro-anatomy—but has been common property of all those who ever conscientiously tried to master the subject. One of the leading brain-anatomists of Europe informed me that he was obliged to relearn brain-anatomy every time he gave the course to his students. My former teacher in anatomy used to remind his classes that they would get brain-anatomy twice—get and forget it. It seems almost impossible for the memory to retain the countless names of the various divisions, subdivisions, and multitudinous parts which go to make up the architecture of this most important organ. Much of this difficulty arises from the different terms applied by different writers to identical portions of the brain—the synonyms; but this is about to disappear, as much progress has lately been achieved in neuronymy under the able leadership of Prof. Burt G. Wilder, of Cornell University. His report[2] was adopted unanimously at the

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[1] Presented to the 92d Annual Meeting of the Medical Society of the State of New York, at Albany, January 25, 1898.

[2] *Journal of Nervous and Mental Disease*, December, 1896, p. 793.

1896 meeting of the American Neurological Association, at Philadelphia, and will help to lessen many of the difficulties with which brain-investigators have to contend. The first five sections are substantially identical with reports that were adopted unanimously by the Association of American Anatomists in 1889 and 1892. The recommendations are as follows:

1. That the adjectives dorsal and ventral be employed in place of posterior and anterior, as commonly used in human anatomy, and in place of upper and lower, as sometimes used in comparative anatomy.
2. That the cornua of the spinal cord, and the spinal nerve-roots, be designated as dorsal and ventral, rather than as posterior and anterior.
3. That the costiferous vertebræ be called thoracic rather than dorsal.
4. That other things being equal, mononyms (single-word terms) be preferred to polyonyms (terms consisting of two or more words).
5. That the hippocampus minor be called calcar; the hippocampus major, hippocampus; the pons varolii, pons; the insula Reilii, insula; pia mater and dura mater, respectively pia and dura.
6. That the following be employed rather than their various synonyms: Hypophysis, epiphysis (for conarium and corpus pineale), chiasma, oblongata, lemniscus, monticulus, tegmentum, pulvinar, falx, tentorium, thalamus, callosum, striatum, dentatum, mesencephalon, pallium, oliva, clava, operculum, fissura centralis (for f. Rolando, etc.), F. calcarina, F. collateralis, F. hippocampi, cuneus, precuneus, claustrum, fornix, infundibulum, vermis.

But even with the universal adoption of these terms, brain-anatomy will seem almost as complex and evasive as before, and any aid or rules which will lighten this burden will prove welcome.

The following rules which I have formulated have been a great aid to me in remembering the gross anatomy of the brain, and may be of assistance and benefit to others:

Rule of Two.—1. The nerve-centers are divided into two great divisions: (1) encephalon, (2) myelon.

2. The encephalon is divided into two subdivisions: (1) cerebrum and (2) cerebellum.

3. The cerebrum, cerebellum and myelon are divided into two hemispheres each: (1) right and (2) left.

4. The encephalon is indented by two great fissures: (1) longitudinal and (2) transverse.

5. Into these two great fissures there dip two folds of the dura: (1) the falx cerebri and (2) the tentorium cerebelli.

6. There are two varieties of brain-matter: (1) white and (2) gray.

Rule of Three.—1. There are three layers of membrane surrounding the brain: (1) the dura, (2) the arachnoid, and (3) the pia.

2. Each hemisphere is indented by three major fissures: (1) the sylvian, (2) rolandic or central, and (3) parieto-occipital, these serving as boundary-lines between the different lobes.

3. Three lobes, the frontal, temporal, and occipital, on their convex surface, are divided into three convolutions each: the superior, middle, and inferior, or 1st, 2d, and 3d.

4. There are three pairs of basal ganglia: (1) the striata, (2) thalami, and (3) quadrigemina.

5. The hemispheres of the brain are connected by three commissures: (1) the pre, (2) medi, and (3) postcommissure.

6. The cerebellum consists of three portions: (1) the right and (2) the left hemispheres, and (3) the vermis.

7. There are three pairs of cerebellar peduncles: (1)

the superior, (2) middle, and (3) inferior, or pre, medi and post peduncles.

8. The number of pairs of cranial nerves in the classifications of Willis and Sömmering can be determined by adding 3 to the number of letters in each name; that of Willis making 9, and that of Sömmering making 12 (or the name containing the more letters has the larger number of pairs of nerves, and vice versa).

9. The cortex of the cerebellum is divided into three layers of cells: (1) the granular, (2) Purkinje's cells, and (3) a molecular layer.

Rule of Five.—Each hemisphere is divided externally into five lobes, of which four are visible: (1) frontal, (2) parietal, (3) temporal, (4) occipital; and one invisible, the fifth or insula (Isle of Reil). Roughly speaking, the visible lobes correspond to the bones of the cranium; that is, the frontal lobe is underneath the frontal bone, the parietal lobe beneath the parietal bone, and so on.

2. The brain contains five ventricles, of which four are visible, the right and left, or 1st and 2d, the 3d, and the 4th; and one invisible, the 5th or pseudo-ventricle, between the two layers of the septum lucidum.

3. The cortex of the brain contains 5 distinct layers of ganglion-cells.

Recapitulation.

Rule of "Two."

Nerve centers—
    1. Encephalon. 2. Myelon.

Encephalon—
    1. Cerebrum. 2. Cerebellum.

Cerebrum
Cerebellum } 1. Right hemisphere. 2. Left hemisphere.
Myelon

Fissures—
    1. Longitudinal. 2. Transverse.

Dura-folds—
    1. Falx. 2. Tentorium.

Brain-matter—
    1. White. 2. Gray.

Rule of "Three."

Membranes—
1. Dura. 2. Arachnoid. 3. Pia.

Hemispheral fissures—
1. Sylvian. 2. Central (Rolandic). 3. Parieto-occipital.

Convolutions—
Lobes { 1. Frontal, 2. Temporal, 3. Occipital } 1. First. 2. Second. 3. Third
or
1. Superior. 2. Middle. 3. Inferior.

Commissures—
1. Pre. 2. Medi. 3. Post.

Basal ganglia, pairs—
1. Striata. 2. Thalami. 3. Quadrigemina.

Cerebellum—
1. Right hemisphere. 2. Left hemisphere.
3. Vermis.

Cerebellar peduncles, pairs—
1. Pre. 2. Medi. 3. Post.

Cerebellar cortex-layers—
1. Granular. 2. Purkinje's. 3. Molecular.

Cranial nerves, pairs—
W-i-l-l-i-s plus 3 = 9.
S-ö m-m-e-r-i-n-g plus 3 = 12.

Rule of "Five."

Hemispheral lobes—
Visible: 1. Frontal. 2. Parietal. 3. Temporal.
4. Occipital.
Invisible: 5. Insula.

Ventricles—
Visible: 1. First. 2. Second. 3. Third. 4. Fourth.
Invisible: 5. Fifth (pseudo-ventricle)

Cerebral cortex—
Five layers of ganglion-cells.

CHOKED DISC, OPTIC NEURITIS OR PAPILLITIS.[3]—Having noted the continued presence of this symptom in my cases of brain-tumor 12 times out of 13 cases, and once probably present, I determined to ascertain, if possible, the class of cases in which choked disc was absent, or whether the nature of the growth, its location, size, or period of growth, had any decided influence over the determination of a neuritis. If choked disc depended upon an increased intracranial pressure, its absence would be looked for in tumors of small size and slow growth. If to microbic influences, then its absence would be noted in nonpathogenic neoplasms.

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[3] In this paper the terms optic neuritis, choked disc, and papillitis are used synonymously.

Another problem, the solution of which was attempted, was whether the location of the tumor had any bearing upon the appearance of optic neuritis; as, for instance, as has been remarked by some observers, that pons tumors or basal tumors predispose less to optic neuritis than cortical tumors; or that cerebellar tumors are more often accompanied by choked disc than cerebral tumors.

Some of the other queries whose solutions were desired were as to whether unilateral choked disc determined the hemisphere in which the tumor was located; whether the greater intensity of the neuritis in one eye indicated the side containing the tumor, and whether the early or late appearance of optic neuritis indicated anything in the nature, character, location, or period of growth of the tumor.

To study these different problems, 100 cases of brain-tumor (cerebral) were selected from recent literature, in which an ophthalmoscopic examination had been made and the presence or absence of choked disc, or optic neuritis, had been definitely determined. The symptoms, location of growth, and its nature were carefully tabulated and the results obtained are briefly as follows:

Of these 100 cases, choked disc or optic neuritis was absent in 9 cases and present in 91, and, as a symptom of brain-tumor, was second in frequency to the head-pains. These figures are somewhat higher than those reported by other observers, as the following percentages will show:

Gowers found optic neuritis present in 80% of his cases; Oppenheim[4] in 82%; Köster[5] in 8 out of 9 personal cases, or as frequently as the head-pains; Knapp $66\frac{2}{3}\%$; Edmunds and Lawford in an analysis of 107 cases of brain-tumor found it present in 68 cases.

In those cases in which it was absent, 6 were tumors in the motor areas, 4 on the left and 2 on the right side. Two were tumors in the temporal lobe, 1 was a tumor in the frontal lobe. This result would appear to favor the motor areas (ascending frontal and ascending parietal convolutions, or precentral and postcentral) as the region of the brain least favorable for the development of optic neuritis; but on examining the 91 cases in which optic neuritis was present, 33, or over one-third, were found to be tumors in the motor areas. In 18 cases of tumor of the frontal lobe, optic neuritis was present, while it was absent in only one case. In 3 cases of temporal lobe disease optic neuritis was present, while its absence was noted in only 2 cases. In pons tumors, in which according to some authors optic neuritis is very prone to be absent or very late in making an appearance, it was present in 11 cases, and in no case was it reported absent.

In an analysis of 100 cases of cerebellar disease reported to this society in 1895,[6] optic neuritis was present in 66 cases, absent in 12, and not reported in 23 This would tend to show that it is more frequently met in cerebral than in cerebellar tumors. It is well known that cysts and abscesses of the brain predispose less to optic neuritis than tumors. Thus, in an analysis of 50 cases, optic neuritis was present in 16 cases; absent in 24, doubtful in 2, and not mentioned in 8. In the majority of the cases in which optic neuritis was present it appeared very late and was generally very slight.

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[4] Die Geschwülste des Gehirns, 1896.

[5] Abstract *Neurologisches Centralblatt*, 1897, No. 2.

[6] *New York Medical Journal*, June 1, 1895. Transactions New York State Medical Society, 1895.

The size, growth, and character of the tumor, as bearing upon the increase of intracranial pressure in calling forth an optic neuritis, is worth considering, and in the 9 cases[7] in which optic neuritis was absent the following conditions were present:

Case 1 was a fibroma of slow growth, size not mentioned; case 2 was a glioma of five years' growth, a small part of which was the size of a hickory-nut; case 3 was a case of general tuberculosis of the brain with distended ventricles; case 4 was an infiltrating tumor, the size of an orange; case 5 was a cicatricial-looking mass, about 1½ in. in diameter; case 7 was a small perithelioma; case 8 was a spindle-celled sarcoma the size of an apple, and case 9 was a tumor the size of a hen's egg surrounded by an infiltrating glioma.

The size of the tumors, therefore, as shown by the autopsy-findings, varied from a small perithelioma to a spindle-celled sarcoma, the size of an apple (case 8). Nearly all tumors were of large size, as in cases 2, 9, 6, and 5, the smallest of the group (5) being 1½ in. in diameter. In case 3, although the size of the tubercular nodules is not mentioned, yet the lateral ventricles were enlarged and distended, increasing intracranial tension greatly thereby. In the case of the fibroma (1), such a dense, firm, unyielding mass, however small its size, would also greatly increase the pressure. It would seem probable, therefore, if optic neuritis were totally absent in these cases up to the time of death, that some agent or process, other than increased intracranial pressure, were necessary to have produced choked disc or optic neuritis, because here was pressure very pronounced even, and yet no neuritis, according to competent careful observers, had been found. If the Leber-Deutschmann theory be accepted, then the neuritis is the result of some irritating agent from the tumor, or inflammation, finding its way into the cerebrospinal fluid and by the increased intracranial pressure being forced into the sheaths of the optic nerves, producing edema and a true optic neuritis. This is perhaps the best explanation of the origin of optic neuritis, and shows how the increased intracranial pressure is made to play an important part in the etiology of this important symptom.

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[7] Case 1. Pel, *Berliner klinische Wochenschrift*, 1894, No. 5.
" 2. Mills and McConnell, *Journal of Nerv. and Mental Dis.*, Jan., 1895.
" 3. Finlayson, *Glasgow Medical Journal*, Aug., 1896.
" 4. Sinkler, *Trans. American Neurological Assoc'n*, 1896.
" 5. Church and Fauk, *Amer. Jour. Medical Sciences*, July, 1896.
" 6. Thomas and Bartlett, *Hahnemannian Monthly*, May, 1890.
" 7. Ziehl and Roth, *Deutsche medicinische Wochenschrift*, 1897, No. 19.
" 8. Schultz, Fr., *Deutsche Zeitschrift f. Nervenheilkunde*, 1896.
" 9. Pershing, *Trans. American Neurological Assoc'n*, 1897.

The period of growth varied considerably in these tumors between the first manifestations of the symptoms and the termination in death, or operation. In case 1, over a year elapsed; in case 2, five years; in case 3, a very short time; in case 4, over seven years, and 54 days after the operation; in case 5, ten months elapsed before the operation; in case 6, nearly two and one-half years transpired between first symptom and operation; in case 7, nine months elapsed; in case 8, a trauma was received in 1893, and the patient was operated on in 1896; and in case 9, over two years had elapsed.

It would seem, therefore, that slow-growing tumors, such as these all were with the exception of case 3, predisposed less to the occurrence of optic neuritis than those of rapid growth.

The nature of the tumors in these cases varied, and it is questionable whether any of them, with the exception of the tubercles in case 3, can be considered of microbic origin. The sarcomata have as yet not been definitely placed among the parasitic tumors, hence, their toxins were not able to produce a toxic neuritis. Out of the 91 cases, 8 were of tubercular and 15 of syphilitic origin, while 37 were sarcomatous and 17 gliomatous. Here again it is impossible to derive any positive data regarding the relation between the tumor and the development of the neuritis. It is hardly probable, however, that the optic neuritis depends upon a specific virus emanating from specific tumors, thus producing a toxic neuritis. The "irritants" of Leber, Deutschmann, Adamkiewicz, and others, which are supposed to play such an important role, have not been, as yet, defined.

The data upon which to base an opinion regarding unilateral optic neuritis, the unequal intensity of the neuritis and its early or late appearance as indicative of special location, were so meager that nothing very positive can be affirmed. It is probable, however, that a unilateral neuritis and the neuritis of greater intensity stand in communication with the diseased hemisphere; or, in other words, that a neuritis will be found in the eye corresponding to the side of the brain affected.

A point not always stated in these negative cases was the number of times an ophthalmoscopic examination had been made, and also the length of time before death, or operation, of such examinations. In many of the cases analyzed, optic neuritis was reported as occurring "very late" or "just before death," and some observers held the diagnosis of brain-tumor in abeyance because of the nonappearance or rather tardy appearance of this symptom. Thus, in a case of my own, operation was postponed for some weeks because of the normal appearance of the discs, and then undertaken on the sudden acute manifestation of the neuritis, and yet on autopsy the brain had evidently been the seat of disease (multiple sarcoma) for months. It is possible, therefore, that an optic neuritis may be discovered in some cases reported as negative if the ophthalmoscope were used daily and up to the time of dissolution. Sanger reported a case to the Hamburg Medical Society in which the absence of optic neuritis and a previous history of syphilis led him to the belief that a syphilitic basilar meningitis was present. A day or two before the patient's unexpected sudden death, a light degree of optic neuritis appeared; the autopsy revealed a sarcoma of the right occipital lobe penetrating the cerebellum.

In all suspected brain-cases the fundus of the eye should be examined repeatedly, if not daily, for the appearance of a papillitis, as its presence is almost pathognomonic of cerebral neoplasm and may aid definitely in differentiating between a diagnosis of functional brain-disturbance and organic brain-disease.

Despite the fact that optic neuritis was absent in these cases, the other symptoms were so prominent, especially localizing symptoms, as paresis (8 out of 9 cases), that an operation was resorted to in cases 1, 4, 5, 6, 7, and 8. Death occurred in all cases, except 5 and 7, from a few hours to 54 days (case 3) after the operation. As to the sex of these patients, while not exerting any influence over the production of optic neuritis, it may be interesting to know that five were males, and three females, while the sex of one patient, a child of 19 months, was not stated. The age varied from 19 months (case 3) to 60 years (case 7), and in this case a second operation was performed and the patient recovered.

The importance of trauma in the production of brain-tumors should not be lost sight of and seemingly exerts considerable influence, as three of these cases ascribe the beginning of their affliction to some blow on the head.

In the 91 cases a large number gave similar evidence, and in one case the symptoms gradually followed the boxing of a pupil's ears by a brutal school-teacher.[8] Another similar case was reported by Donath,[9] of an apprentice who was struck on the side of his head by his master, and an extensive sarcomatous disease of the cerebellum was disclosed at the autopsy.

The conclusions to be drawn from my study of these cases are as follows:

1. Optic neuritis is present in about 90% of all cases of brain-tumor.

2. It is more often present in cerebral than in cerebellar cases.

3. The location of the tumor exerts little influence over the appearance of the papillitis.

4. The size and nature of the tumor exert but little influence over the production of the papillitis.

5. Tumors of slow growth are less inclined to be accompanied with optic neuritis than those of rapid growth.

6. It is probable that unilateral choked disc is indicative of disease in the hemisphere corresponding to the eye involved.

7. It is doubtful whether increased intracranial pressure is solely and alone responsible for the production of an optic neuritis in cases of brain-tumor

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[8] Hofman, Virchow's *Archiv*, vol. clvi.

[9] *Wiener med. Wochenschrift*, 1896, Nos. 29 and 30.